REMARKS

Claims 1, 2, 6, 26-28, 33 and 53-54 are amended herein.

Claims 17-19 and 21 are canceled.

Claims 56-58 are added.

Claims 1-16, 20, and 22-58 are now pending.

The specification is amended to correct minor typographical errors.

Response to Claim Objections

Claim 2 is objected to because of informality. Applicants have amended claim 2 to correct the informality.

Response to Double Patenting Rejection

The Examiner provisionally rejected claims 1, 27, 28, 53, 54 and 55 on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 1 and 17-20 of copending application No. 11/265533. Should the copending application issue as a patent, Applicants will file a Terminal Disclaimer as needed.

Response to Rejection Under 35 USC § 112

Claim 2 is rejected due to insufficient antecedent basis for the limitation in the claim. Applicants have amended the claim to provide sufficient antecedent basis.

Response to Rejection Under 35 USC § 101

The Examiner has rejected claim 54 under USC §101 as allegedly directed to non-statutory subject matter. Applicants have amended the claim as suggested by the Examiner to recite a statutory subject matter.

Response to Rejection Under 35 USC § 102

Claims 1-18 and 20-55 were rejected under 35 U.S.C. 102(e) as being anticipated by

Biswas et al (US 7,197,074) ("Biswas1"). Applicants respectfully traverse.

As amended, claim 1 now recites:

> A computer implemented method of determining a motion vector for encoding a block of a predicted frame with respect to a reference frame, the method comprising:
> setting a variable threshold for a number of phase correlation peaks according to an encoding parameter for controlling encoding speed and image quality;
> determining a variable number of phase correlation peaks between a phase correlation block of the predicted frame and a corresponding phase correlation block of the reference frame, the phase correlation block of the predicted frame including the block, the variable number corresponding to the variable threshold;
> determining for each phase correlation peak, a motion vector; and
> selecting from the motion vectors, a motion vector that minimizes a distortion measure between the block and a reference block offset from the block by the motion vector.

Claim 26 recites a corresponding method for frame-level motion vector determination, and claims 28 and 53 recite a corresponding circuit apparatus and circuit means, respectively. These features provide methods and apparatuses for determining a motion vector for encoding a predicted block of a predicted frame using phase correlation analysis. A phase correlation analysis between corresponding phase correlation blocks in the predicted frame and reference frame results in a phase correlation surface, which will have a number of peaks, each of which represents underlying motion between the two phase correlation blocks of the associated predicted frame and reference frame. To balance the tradeoff between encoding speed and image quality, the number of phase correlation peaks to be selected for the phase correlation analysis is set using a "variable threshold … according to an encoding parameter." For example, different embodiments may set the variable threshold as a function of the size of the block to be predicted, or based on the distribution of the peaks in the correlation surface. Once the number of phase correlation peaks is determined according to this threshold, the phase correlation peaks are analyzed for selecting the appropriate motion vector for the block

to be predicted. This selection is of the motion vector that minimizes a distortion measure between the blocks of the predict frame and a reference block.

In sum, there are two stages of selection in the claimed method: A first selection stage in which some number of phase correlation peaks are selected—and this number can vary per encoding pass or otherwise—and a second selection stage in which one motion vector associated with these correlation peaks is selected.

Biswas1 does not teach these features. Specifically, Biswas1 does not disclose having a variable threshold for the number of phase correlation peaks. Rather, Biswas1's phase correlation analysis uses a ranker to rank candidate motion vectors according to peak magnitude. As a result of this ranking, candidate motion vectors having <u>an insufficient peak magnitude</u> are omitted in the correlation. See Biswas1, Column 5, lines 14-60. As such, Biswas1 picks candidate motion vectors against "an insufficient peak magnitude", i.e., a single magnitude threshold. Biswas1 does not disclose that such threshold varies according to an encoding parameter for controlling encoding speed and image quality, as claimed. Consequently, Biswas1 does not teach having a variable threshold for determining the number of phase correlation peaks as claimed.

Furthermore, Biswas1 does not teach selecting a motion vector that minimizes a distortion measure between the blocks of the predict frame and a reference block. Instead, Biswas1 simply checks the phase correlation between the current block and the 8 neighboring sub-blocks and compares the similarities between pixel values of these blocks against <u>an error threshold</u>. An error threshold is a limit that specifies a <u>maximum</u> error allowed, and <u>all motion vectors</u> below the limit are candidates. Consequently, Biswas1 accepts vector assignments to sub-blocks wherein the correlation is <u>within the selected limit</u> for error as valid

motion vector assignments. See Biswas1, Column 5, lines 45 to Column 6 line 5. By definition, there will always be more than one motion vector below this error limit, since there has to be multiple candidates. By contrast, the minimizing distortion in the claimed invention is just the opposite: it selects <u>only one single motion vector</u>, e.g., the one with the minimum distortion error. Consequently, there is only one motion vector selected for the sub-block to be predicted in the claim invention. As such, Biswas1 does not disclose such selection criterion that will select only one candidate motion vector that minimizes the distortion between the block of the predict frame and a reference block.

Based on the above remarks, Applicants respectfully submit that for at least these reasons independent claims 1, 26, 28 and 53 are patentably distinguishable over the cited reference. Therefore, Applicants respectfully request that Examiner reconsider the rejection, and withdraw it.

The dependent claims are also patentable over Biswas1, both because each depends from patentable independent claims, respectively, and because each also recites its own patentable features. Therefore, Applicants respectfully submit that claims 1-16, 20, and 22-58 are not anticipated by Biswas1.

<u>Response to Rejection Under 35 USC § 103</u>

Claims 6 and 33 are rejected under 35 U.S.C. 103(a) as being unpatentable over Biswas1 and in view of Zhang et al. (US 6,449,312).

Zhang does not remedy the deficiencies of Biswas1. Zhang discloses a method of estimating motion in video using block matching metric. Zhang's estimation process searches a search window in a reference frame to try to find a match for an image block in a current frame.

First, Zhang's search window is not equivalent to the phase correlation block dimensions (M and N) as claimed. In Zhang, motion estimation in frame mode and field mode is conducted in a given search range, e.g., motion vector search window, and motion displacements (e.g., motion vector magnitude) can be as large as the search window. See Zhang, Column 1, lines 36-44 and Column 3, lines 40-45. In contrast, in the claimed invention, the phase correlation block dimensions are specifically claimed as being more than twice as large as the motion vector search window, e.g., $M > 2S_h + 16$, and $N > 2S_v + 16$, where S_h and S_v are the maximum search range in the horizontal and vertical direction, respectively. For example, assuming that the motion vector search window used in both Zhang and the claimed invention is 128, the phase correlation block dimensions would be 272x272 (i.e., 2S+16), instead of 128x128. The choice of M and N in this matter is beneficial in that it ensures that the phase correlation block is large enough to fully cover the entire search area for a macroblock of size 16x16 located at the center of the phase correlation block.

Thus, claims 6 and 33 are patentable over Biswas1 and Zhang, both individually and in combination. Other independent claims recite similar language and are also patentable over Biswas1 and Zhang, both individually and in combination.

The claims not mentioned above depend from their respective base claims, which are patentable over Biswas1 and Zhang, both individually and in combination. In addition, these claims recite other features not included in their respective base claims. Thus, these claims are also patentable over Biswas1 and Zhang, both individually and in combination.

Claims 6 and 33 are rejected under 35 USC §103 (a) as being unpatentable over Biswas1 in view of Aude. Aude does not remedy the deficiencies of Biswas1 and Zhang.

Aude teaches coherent and windowed sampling with A/D converters. Aude does not disclose or teach analyzing every candidate motion vector via phase correlation analysis and determining the number of phase correlation peaks using a variable threshold as claimed.

Claims 20, 21, 47 and 48 are rejected under USC §103 (a) as being unpatentable over Biswas1 in view of Biswas et al. "A Novel Motion Estimation Algorithm Using Phase Plane Correlation for Frame Rate Conversion" (Biswas2). Biwas2 does not remedy Biswas1, Zhang and Aude. Biswas2 teaches using phase plane correlation for frame rate conversion. Biswas2 uses a threshold value to evaluate the similarity between the current block of interest and its 8 neighbors. See Biswas2, Section 3. However, this threshold is unrelated to the variance of the phase correlation peak values. Further, because Biswas2 is merely a further elaboration of Biswas1, the combination of these references provides nothing more than what Biswas2 alone discloses. As such, Biswas2 does not disclose determining <u>a number of correlation peaks as a function of a variance</u> of the values of the phase correlation peaks. Therefore, claims 20, 21, 47 and 48 are patentable over Biswas2 and other cited references, both individually and in combination.

In sum, claim 1 is patentable over all cited references, both individually and in combination. Other independent claims recite similar language and are also patentable over all cited references, both individually and in combination. The claims not mentioned above depend from their respective base claims, which are patentable over all cited references, both individually and in combination. In addition, these claims recite other features not included in their respective base claims. Thus, these claims are also patentable over all cited references, both individually and in combination.

<u>Conclusion</u>

Applicants respectfully submit that the pending claims are allowable over the cited art of record for at least the above reasons and request that the Examiner allow this case. The Examiner is invited to contact the undersigned in order to advance the prosecution of this application.

Respectfully submitted,
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